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(54) **USE OF POLY(BIPHENYL ETHER SULFONE)S**

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(57) **ABSTRACT**

Use of an effective amount (ϵ) of a poly(biphenyl ether sulfone) (P2) for diluting a poly(aryl ether ketone) (P1) contained in a polymer composition (C1) consisting of the poly(aryl ether ketone) (P1) and, optionally in addition, one or more ingredients (A) other than the poly(aryl ether ketone) (P1) and the poly(biphenyl ether sulfone) (P2), while at least substantially maintaining the friction and/or wear resistance of the polymer composition (C1) with regard to a surface (Σ) with regard to which respectively the friction and/or wear resistance of the poly(biphenyl ether sulfone) (P2) are not as good as respectively the friction and/or wear resistance of the poly(aryl ether ketone) (P1).

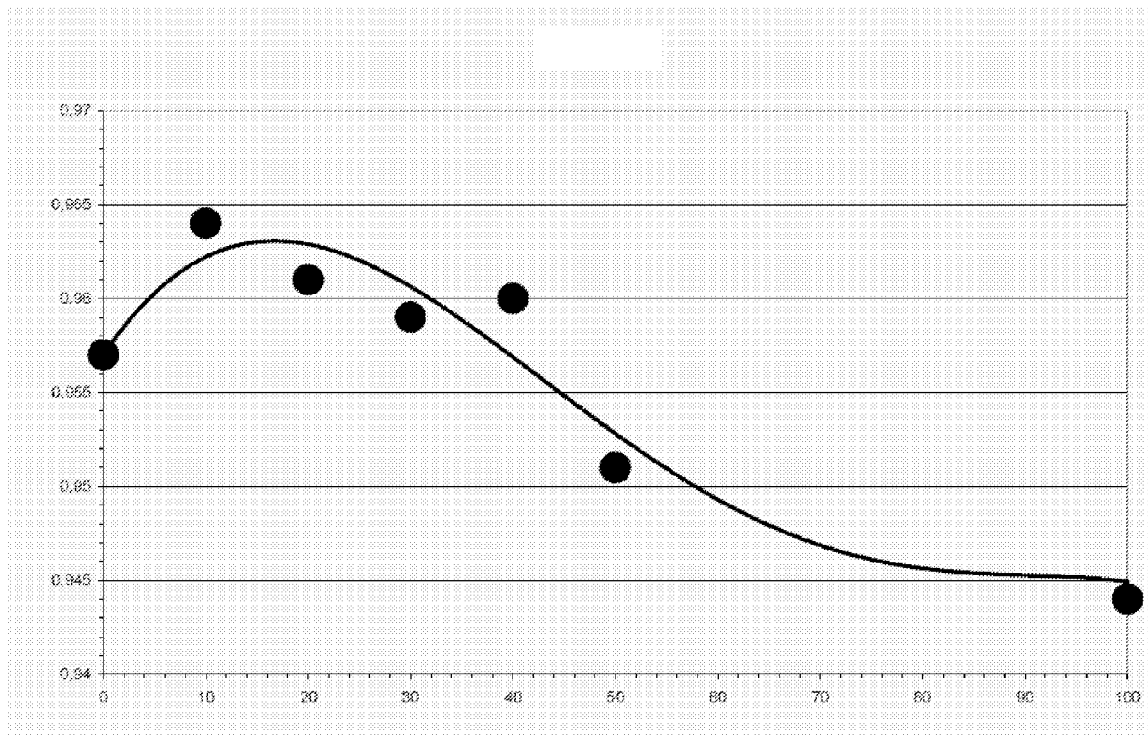
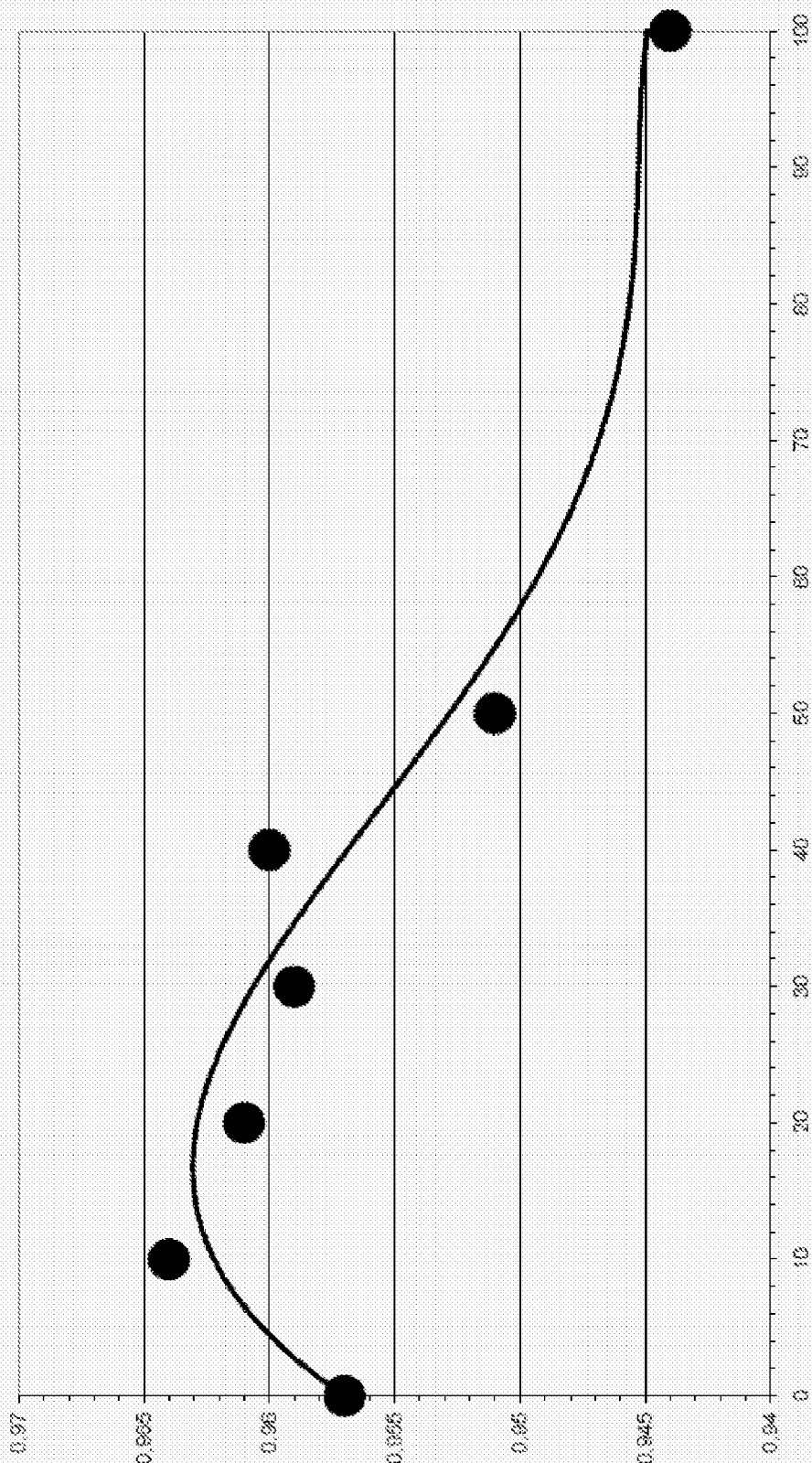


Figure 1



USE OF POLY(BIPHENYL ETHER SULFONE)S

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. applications Ser. No. 60/752,922 and 60/752,951, both filed Dec. 23, 2005, the whole content of which is herein incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a new use of poly(biphenyl ether sulfone)s.

BACKGROUND OF THE INVENTION

[0003] Poly(biphenyl ether sulfone)s form a specific class of poly(aryl ether sulfone)s. These amorphous technopolymers are materials of choice notably for the ultimate in toughness with a rather good friction and wear resistance, although lower than those of ultra-performance polymers like poly(aryl ether ketone)s.

[0004] Precisely, poly(aryl ether ketone)s offer an exceptional balance of technical properties, namely high melting point, excellent thermal stability and excellent friction and wear resistance. However, the somewhat low glass transition of these materials limits their use in certain specific applications where the use temperature is above 170° C.: this is primarily because of the loss of modulus as the glass transition is traversed.

[0005] In lots of applications, the exceptional balance of technical properties offered by poly(aryl ether ketone)s is plainly appreciated and in said applications, there is e.g. no need for a material that would have improved load bearing capabilities above the T_g of neat poly(aryl ether ketone). An important problem remains still, due to the high cost of the poly(aryl ether ketone)s, which prevents the skilled person from using said poly(aryl ether ketone)s as widely as technically desirable for the encompassed applications, in particular when the shaped articles or at least one or more parts thereof are, temporarily or permanently, sliding, or more generally moving, along a more or less rough and/or abrasive surface.

[0006] PAEK's, and in particular PEEK, offer indeed among the highest abrasion resistance and are "low sloughing". These properties make them ideal for applications where particulate generation cannot be tolerated, such as for sensitive electronic components which have very strict requirements for extractables in clean room.

[0007] There remains thus a strong need for a polymer composition with a lower cost than that of poly(aryl ether ketone) compositions, but a friction and wear resistance at least substantially the same as the one obtained by said poly(aryl ether ketone) compositions.

[0008] The challenge appeared tricky for the Applicant, especially in view of the teachings of U.S. Pat. No. 4,804,724, as commented below.

[0009] U.S. Pat. No. 4,804,724, the whole content of which is herein incorporated by reference, describes blends comprising a poly(biphenyl ether sulfone) and a poly(aryl ether ketone). Per U.S. '724, these blends, at intermediate compositions (such as 50 parts of PPSU and 50 parts of PEEK), exhibit a deemed "interesting" balance of properties, i.e. in fact an intermediate level of properties, notably as concerns

modulus, impact resistance, solvent resistance and environmental stress rupture resistance. Thus, based on this disclosure, adding a poly(biphenyl ether sulfone) to a poly(aryl ether ketone) is likely expected to cause a substantial decrease of the friction and wear resistance, and the skilled in the art would have understood that replacing part of the poly(aryl ether ketone) contained in a poly(aryl ether ketone) composition by a usually more cost-attractive polymer, in particular a poly(biphenyl ether sulfone), should not be an appropriate means to solve the complex problem of reducing the cost of the poly(aryl ether ketone) composition while substantially maintaining the friction and/or wear resistance conferred by the poly(aryl ether ketone).

The Invention

[0010] A first aspect of the present invention is directed to the use of an effective amount (ϵ) of a poly(biphenyl ether sulfone) (P2) for diluting a poly(aryl ether ketone) (P1) contained in a polymer composition (C1) consisting of the poly(aryl ether ketone) (P1) and, optionally in addition, one or more ingredients (A) other than the poly(aryl ether ketone) (P1) and the poly(biphenyl ether sulfone) (P2), while at least substantially maintaining the friction and/or wear resistance of the polymer composition (C1) with regard to a surface (Σ) with regard to which respectively the friction and/or wear resistance of the poly(biphenyl ether sulfone) (P2) are not as good as respectively the friction and/or wear resistance of the poly(aryl ether ketone) (P1).

[0011] Another aspect of the present invention is directed to a method for diluting a poly(aryl ether ketone) (P1) contained in a polymer composition (C1) while at least substantially maintaining the friction and/or wear resistance of the polymer composition (C1) in the need thereof,

said polymer composition (C1) consisting of the poly(aryl ether ketone) (P1) and, optionally in addition, one or more ingredients (A) other than the poly(aryl ether ketone) (P1) and a poly(biphenyl ether sulfone) (P2),

said friction and/or wear resistance of the polymer composition (C1) being at least substantially maintained with regard to a surface (Σ) with regard to which respectively the friction and/or wear resistance of the poly(biphenyl ether sulfone) (P2) are not as good as respectively the friction and/or wear resistance of the poly(aryl ether ketone) (P1), said method comprising diluting the poly(aryl ether ketone) (P1) by an effective amount (ϵ) of the poly(biphenyl ether sulfone) (P2).

[0012] According to the above two aspects, the polymer composition (C1) may be in the form of a shaped article or part of a shaped article (S1).

[0013] Let us denote (C2) the polymer composition which can be obtained after the dilution of the poly(aryl ether ketone) (P1), in contrast with (C1) which denotes the polymer composition before the dilution.

[0014] Then, still another aspect of the present invention is directed to a polymer composition (C2) consisting of:

[0015] a poly(aryl ether ketone) (P1)

[0016] an effective amount (ϵ) of a poly(biphenyl ether sulfone) (P2), and

[0017] optionally in addition, one or more ingredients (A) other than the poly(aryl ether ketone) (P1) and the poly(biphenyl ether sulfone) (P2),

wherein the friction and/or wear resistance of said polymer composition (C2) with regard to a surface (Σ) with regard to which respectively the friction and/or wear resistance of the poly(biphenyl ether sulfone) (P2) are not as good as respec-

tively the friction and/or wear resistance of the poly(aryl ether ketone) (P1), are at least substantially maintained, when compared to those of a polymer composition (C1) identical to the polymer composition (C2), except the poly(biphenyl ether sulfone) (P2) contained in the polymer composition (C2) has been completely replaced, weight pro weight, by the poly(aryl ether ketone) (P1).

[0018] Starting usually from a polymer composition (C1) consisting of 100 parts by weight (pbw.) of the poly(aryl ether ketone) (P1) and, optionally in addition, one or more ingredients (A) other than the poly(aryl ether ketone) (P1) and the poly(biphenyl ether sulfone) (P2), a polymer composition (C2) consisting of:

[0019] a poly(aryl ether ketone) (P1), in an amount of (100-8) pbw., ϵ as defined below,

[0020] an effective amount (ϵ pbw.) of a poly(biphenyl ether sulfone) (P2), and

[0021] optionally in addition, one or more ingredients (A) other than the poly(aryl ether ketone) (P1) and the poly(biphenyl ether sulfone) (P2),

can be prepared by a method comprising:

[0022] providing the poly(biphenyl ether sulfone) (P2);

[0023] providing the poly(aryl ether ketone) (P1);

[0024] providing the ingredients (A), if any;

[0025] contacting, preferably mixing, an effective amount, namely ϵ pbw., of the poly(biphenyl ether sulfone) (P2) with (100-8) pbw. of the poly(aryl ether ketone) (P1) and, the case being, the ingredients (A),

so as to obtain the polymer composition (C2).

[0026] Still another aspect of the present invention is directed to a shaped article or to a part of a shaped article (S2) composed of the polymer composition (C2) as above described. A last aspect of the present invention is directed to an article assembly comprising said part.

DETAILED DESCRIPTION OF THE INVENTION

[0027] For the sake of clarity, the expression “for diluting a poly(aryl ether ketone) (P1) contained in a polymer composition (C1)” should herein be understood in its broad sense, namely: “for reducing the concentration of the concentration of the poly(aryl ether ketone) (P1) contained in the polymer composition (C1)”. Typically, such dilution can be achieved by replacing part of the poly(aryl ether ketone) (P1) by the poly(biphenyl ether sulfone) (P2). A frequent benefit resulting from the dilution of the “concentrated” polymer composition [namely, the polymer composition (C1)] is that the so-obtained “diluted” polymer composition [namely, the polymer composition (C2)] is more cost-attractive, because poly(biphenyl ether sulfone)(s) are usually not as expensive as poly(aryl ether ketone)s.

[0028] The polymer composition (C1) may have been prepared and its friction and/or wear resistance may have been assessed by a certain skilled person, before said skilled person uses the poly(biphenyl ether sulfone) (P2) for diluting the poly(aryl ether ketone) (P1) contained in the polymer composition (C1) in accordance with the presently invented use. This scenario is however not required at all: the presently invented use should be understood to be implemented as well, notably, as soon as a polymer concentration (C2) is conceived by a skilled person to the purpose of exhibiting a friction and/or wear resistance with regard to a certain surface (Σ), at least substantially equal to the effectively measured or reasonably estimated, respective friction and/or wear resistance of a poly(aryl ether ketone)-containing poly(biphenyl ether

sulfone)-free polymer composition (C1), whatever the way this person has been made aware of the effectively measured or reasonably estimated, respective friction and/or wear resistance of the polymer composition (C1), and the so-conceived polymer composition (C2) is then prepared on this basis.

[0029] The fact that, according to the present invention, the friction and/or wear resistance of the polymer composition (C1) are at least substantially maintained means usually that the polymer composition (C2) (the “diluted” polymer composition) has respectively a friction and/or wear resistance with regard to the surface (Σ) which are either lower than but close to those of polymer concentration (C1) (the “concentrated” polymer composition), or equal to those of polymer concentration (C1), or greater than those of polymer concentration (C1). Otherwise said, with regard to the surface (Σ), the polymer composition (C2) has not a friction and/or wear resistance substantially lower than those of polymer concentration (C1).

[0030] Preferably, in the present invention, the friction and/or wear resistance of the polymer composition (C1) are at least essentially maintained, i.e. the polymer composition (C2) has usually respectively a friction and/or wear resistance with regard to the surface (Σ) which are the same or essentially the same as those of polymer concentration (C1), or they are greater than those of polymer concentration (C1).

[0031] In a certain embodiment of the present invention, the friction resistance of the polymer composition (C1) with regard to the surface (Σ) is at least substantially maintained; in this embodiment, the wear resistance may be maintained or not.

[0032] In a certain other embodiment of the present invention, at least the wear resistance of the polymer composition (C1) with regard to the surface (Σ) is at least substantially maintained; in this embodiment, the friction resistance may be maintained or not.

[0033] In a certain still other embodiment of the present invention, both the friction and the wear resistance of the polymer composition (C1) with regard to the surface (Σ) are at least substantially maintained.

[0034] Any amount of poly(biphenyl ether sulfone) (P2) which, when used for diluting the poly(aryl ether ketone) (P1) contained in the polymer composition (C1), makes it possible to at least substantially maintain [i.e. does not substantially impair] the friction and/or wear resistance of the polymer composition (C1) with regard to the surface (Σ) should be viewed as an effective amount (ϵ), in the sense of the present invention.

[0035] As already explained, the effective amount (ϵ) of the poly(biphenyl ether sulfone) (P2) can dilute the poly(aryl ether ketone) (P1) contained in the polymer composition (C1) in an amount of 100 parts by weight (pbw.), by replacing, in said polymer composition (C1), ϵ pbw. of the poly(aryl ether ketone) (P1) by ϵ pbw. of the poly(biphenyl ether sulfone) (P2); thereby, a polymer composition (C2) containing (100- ϵ) pbw. of the poly(aryl ether ketone) (P1) and ϵ pbw. of the poly(biphenyl ether sulfone) (P2) can be obtained. When so defined, ϵ can range between 0 and 100 pbw.

[0036] From a theoretical point of view, ϵ can be as low as technically feasible, but amounts ϵ of poly(biphenyl ether sulfone) (P2), as defined in the previous paragraph, below than 1 pbw., are rarely desirable, because the so-achieved benefits of the dilution are in this case usually marginal. Thus,

the effective amount (ϵ) of the poly(biphenyl ether sulfone) (P2) is preferably above 2 pbw.; very preferably, it is above 5 pbw.

[0037] On the other hand, the effective amount (ϵ) should usually not exceed a certain upper limit, which depends notably on the nature of the poly(biphenyl ether sulfone), the nature of the poly(aryl ether ketone), the nature and amount of optional ingredient(s) (A), and the nature of the surface (Σ). Thus, the skilled in the art will often observe, that when replacing weight pro weight an increasing amount of the poly(aryl ether ketone) (P1) by the poly(biphenyl ether sulfone) (P2), the friction and/or wear resistance of the polymer composition (C1) are at least maintained or, at least substantially maintained [exhibiting a "plateau" or "quasi-plateau" behaviour], as long as the amount of the poly(biphenyl ether sulfone) (P2) does not exceed a critical limit, above which the friction and/or wear resistance decrease substantially, sometimes in a sharp manner, to reach finally a level close to those of the poly(biphenyl ether sulfone) (P1); the overall friction and/or wear resistance curves [i.e. from 0 to 100 parts of the poly(aryl ether ketone) (P1) replaced, weight pro weight, by the poly(biphenyl ether sulfone) (P2)] may sometimes look like a sigmoid.

Thus:

[0038] in certain embodiments of the present invention, the effective amount (ϵ) of the poly(biphenyl ether sulfone) (P2), as previously defined, is preferably below 60 pbw.;

[0039] in certain other embodiments of the present invention, ϵ is preferably below 50 pbw.;

[0040] in still certain other embodiments, ϵ is preferably below 40 pbw.; in still certain other embodiments, ϵ is preferably below 35 pbw.; in still certain other embodiments, ϵ is preferably below 30 pbw.; in still certain other embodiments, ϵ is preferably below 25 pbw.; in still certain other embodiments, ϵ is preferably below 20 pbw.; in still certain other embodiments, ϵ is preferably below 15 pbw.

[0041] The skilled in the art will be easily able to determine the value of ϵ that is best convenient for his use, depending notably on all the above cited parameters.

[0042] In general, in the present invention, the polymer compositions (C1) and (C2) are susceptible of moving temporarily or permanently along the surface (Σ); often, such temporary or permanent movement is effectively achieved.

[0043] Non limitative examples of materials susceptible of constituting part or all of the surface (Σ) include metals, steel, bronze and high engineering thermoplastics.

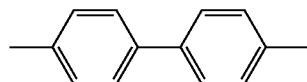
[0044] The friction and/or wear resistance of the polymer compositions (C1) and (C2) with regard to the surface (Σ) can be assessed by any suitable parameters, and said parameters

themselves can be obtained by any suitable methods. An example of such a method is well known as the "Taber® abrasion test".

[0045] This one is commonly used by the skilled in the art to determine the resistance of various plastics to wear (abrasion) using a Taber® abraser. Resistance to wear can be defined as the ability of a material to withstand mechanical action such as rubbing scrapping, or erosion; wear can be difficult to compare but haze variation or weight loss are often evaluated. In accordance with the "Taber® abrasion test", the haze and/or initial weights of the tests specimens are usually measured. Then, the test specimens are usually placed on an abrasion tester; more precisely, a 250, 500, or 1000-gram load is usually placed on top of the abrader wheel. Then, the test specimens are usually allowed to spin for a specified number of revolutions. Different abrading wheels are specified. Haze and/or final weights are usually measured. The load and wheel can be adjusted as a function of the hardness of material of the surface (Σ) is composed, as well known by the skilled in the art. <http://www.ptli.com/testlopeida/subs/Taber-3.asp>

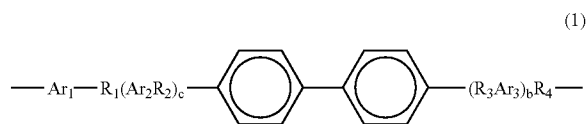
The Poly(Biphenyl Ether Sulfone) (P2)

[0046] For the purpose of the invention, a poly(biphenyl ether sulfone) is intended to denote a polycondensation polymer of which more than 50 wt. % of the recurring units are recurring units (R2) of one or more formulae containing at least one p-biphenylene group:



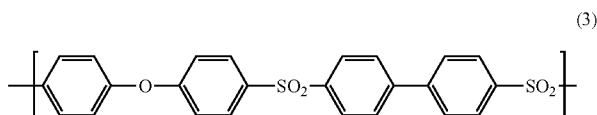
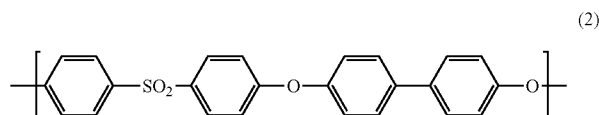
at least one ether group ($-\text{O}-$) and at least one sulfone group ($-\text{SO}_2-$).

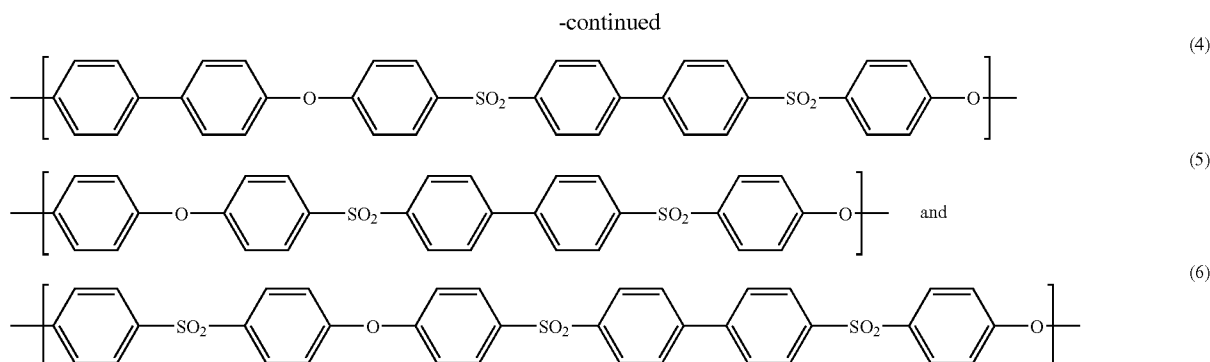
[0047] Preferably, recurring units (R2) are of one or more formulae of the general type:



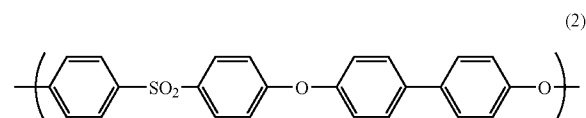
wherein R_1 through R_4 are $-\text{O}-$, $-\text{SO}_2-$, $-\text{S}-$, $-\text{C}(=\text{O})-$, with the proviso that at least one of R_1 through R_4 is $-\text{SO}_2-$ and at least one of R_1 through R_4 is $-\text{O}-$; Ar_1 , Ar_2 and Ar_3 are arylene groups containing 6 to 24 carbon atoms, and are preferably phenylene or p-biphenylene; and a and b are either 0 or 1.

[0048] More preferably, recurring units (R2) are chosen from



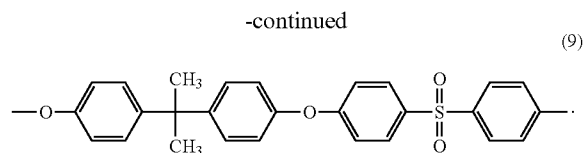
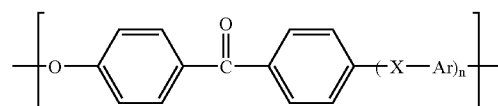
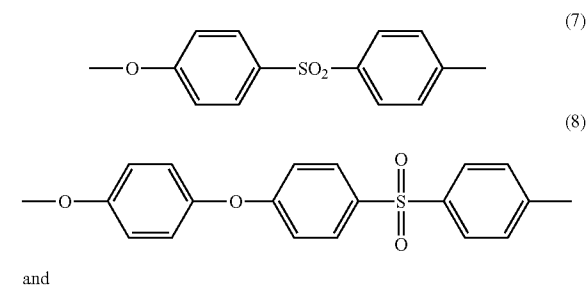


[0049] Still more preferably, recurring units (R2) are



[0050] For the purpose of the present invention, a polyphenylsulfone (PPSU) polymer is intended to denote any polymer of which more than 50 wt. % of the recurring units are recurring units (R2) of formula (2).

[0051] The poly(biphenyl ether sulfone) (P2) may be notably a homopolymer, a random, alternate or block copolymer. When the poly(biphenyl ether sulfone) (P2) is a copolymer, its recurring units may notably be composed of (i) recurring units (R2) of at least two different formulae chosen from formulae (2) to (6), or (ii) recurring units (R2) of one or more formulae (2) to (6) and recurring units (R2*), different from recurring units (R2), such as



[0052] Preferably more than 70 wt. %, more preferably more than 85 wt. % of the recurring units of the poly(biphenyl ether sulfone) (P2) are recurring units (R2). Still more preferably, essentially all the recurring units of the poly(biphenyl ether sulfone) (P2) are recurring units (R2). The most preferably, all the recurring units of the poly(biphenyl ether sulfone) (P2) are recurring units (R2).

[0053] Excellent results were obtained when the poly(biphenyl ether sulfone) (P2) was a PPSU homopolymer, i.e. a polymer of which essentially all, if not all, the recurring units are of formula (2). RADEL® R polyphenylsulfone from Solvay Advanced Polymers, L.L.C. is an example of a PPSU homopolymer.

[0054] The poly(biphenyl ether sulfone) (P2) can be prepared by any method. Methods well known in the art are those described in U.S. Pat. Nos. 3,634,355; 4,008,203; 4,108,837 and 4,175,175, the whole content of which is herein incorporated by reference.

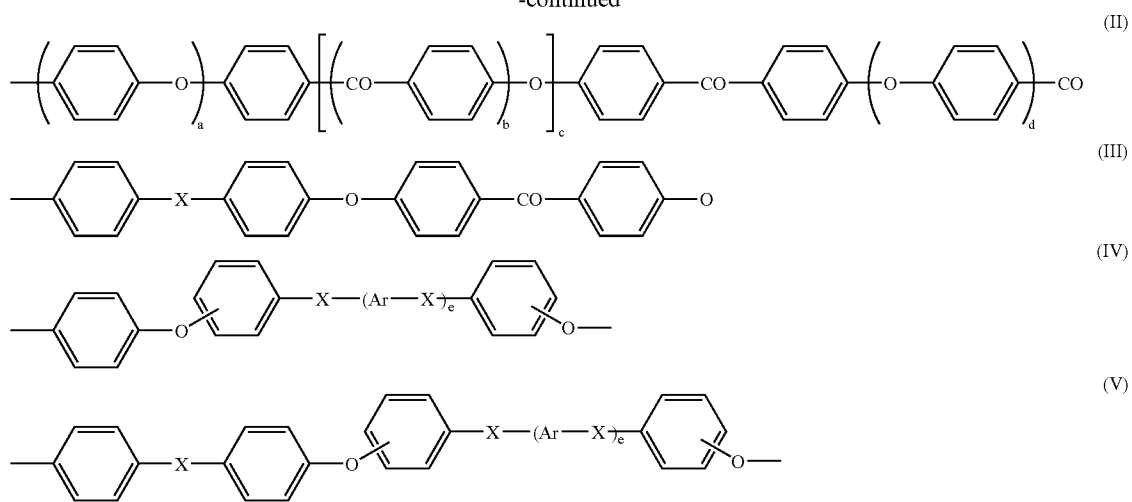
The Poly(Aryl Ether Ketone) (P1)

[0055] As previously mentioned, the polymer composition (C1) contains a poly(aryl ether ketone) (P1).

[0056] For the purpose of the present invention, the term “poly(aryl ether ketone)” is intended to denote any polymer of which more than 50 wt. % of the recurring units are recurring units (R1) of one or more formulae containing at least one arylene group, at least one ether group (—O—) and at least one ketone group [—C(=O)—].

[0057] Preferably, recurring units (R1) are chosen from:

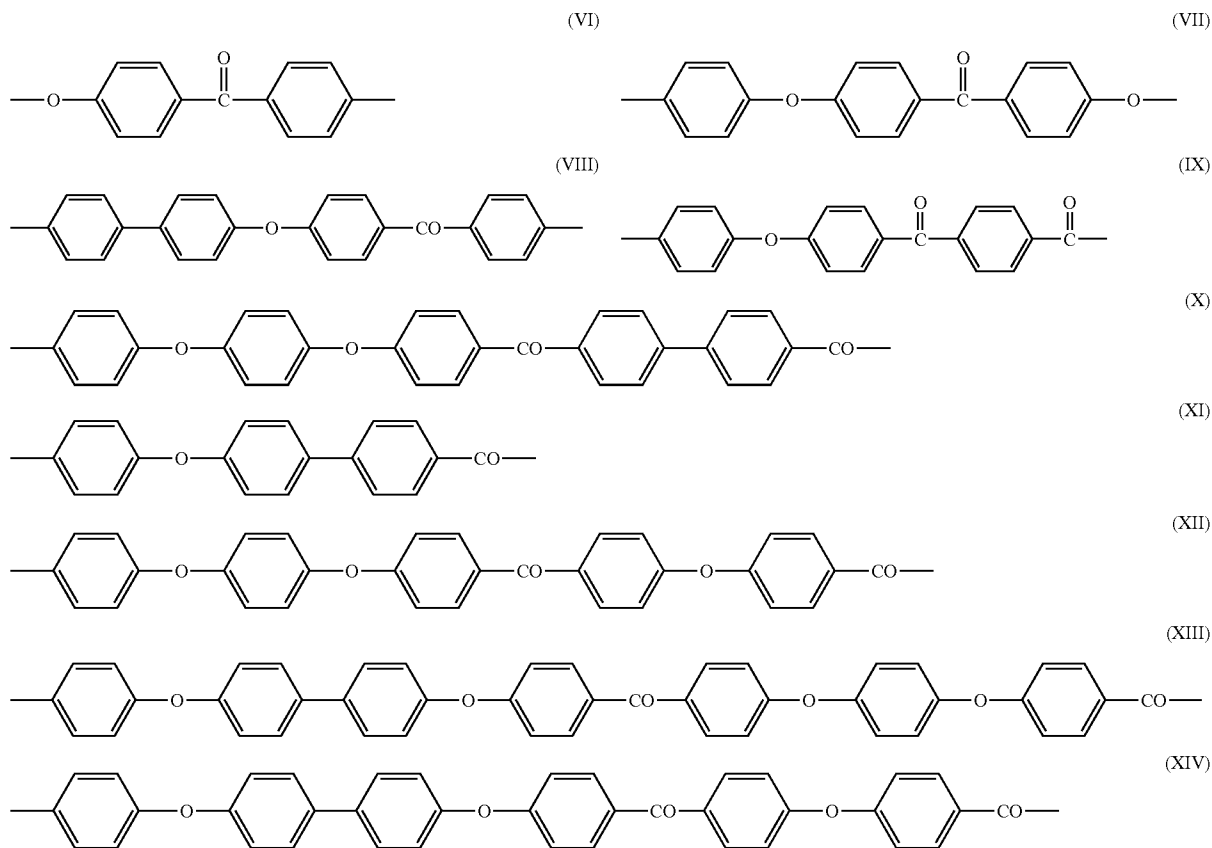
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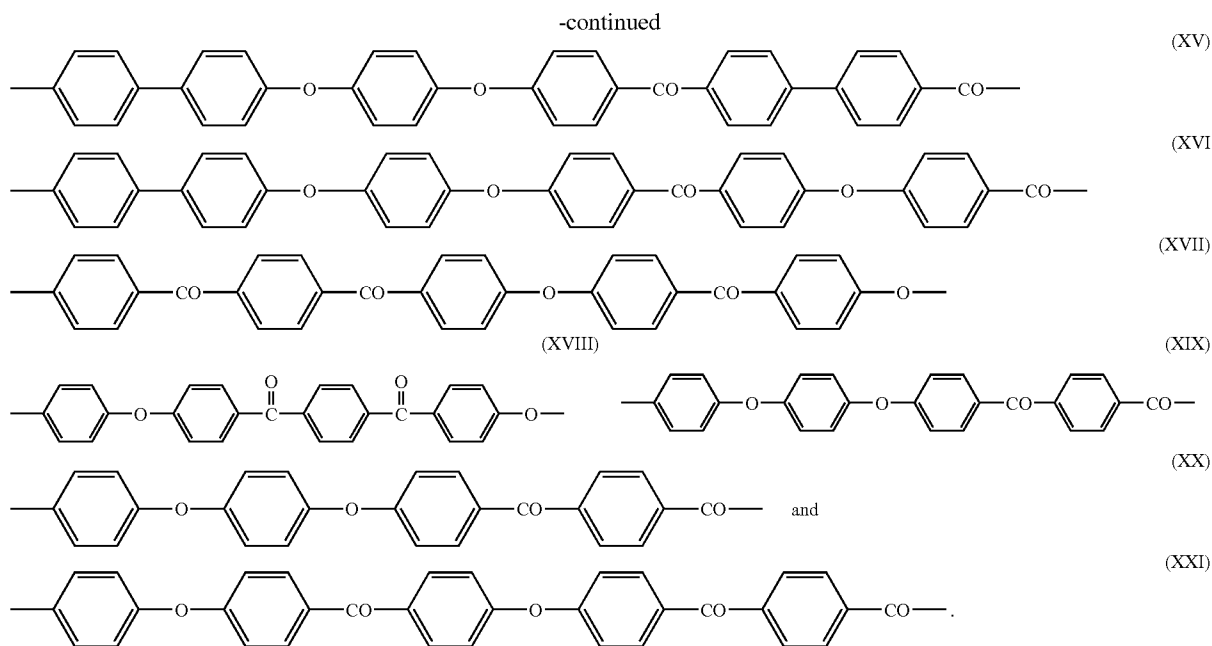


wherein:

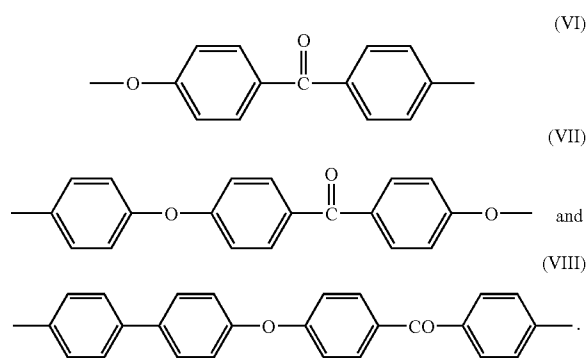
- [0058] Ar is independently a divalent aromatic radical selected from phenylene, biphenylene or naphthylene,
- [0059] X is independently O, C(=O) or a direct bond,
- [0060] n is an integer of from 0 to 3,

- [0061] b, c, d and e are 0 or 1,
- [0062] a is an integer of 1 to 4, and
- [0063] preferably, d is 0 when b is 1.
- [0064] More preferably, recurring units (R1) are chosen from:

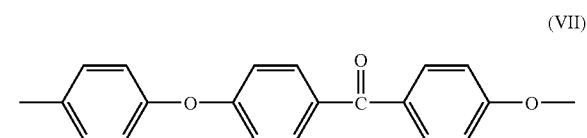




[0065] Still more preferably, recurring (R1) are chosen from:



The most preferably, recurring units (R1) are:



[0066] For the purpose of the present invention, a PEEK polymer is intended to denote any polymer of which more than 50 wt. % of the recurring units are recurring units (R1) of formula (VII).

[0067] The poly(aryl ether ketone) (P1) may be notably a homopolymer, a random, alternate or block copolymer. When the poly(aryl ether ketone) (P1) is a copolymer, it may notably contain (i) recurring units (R1) of at least two different formulae chosen from formulae (VI) to (XXI), or (ii) recurring units (R1) of one or more formulae (VI) to (XXI) and recurring units (R1*) different from recurring units (R1).

[0068] Preferably more than 70 wt. %, more preferably more than 85 wt. % of the recurring units of the poly(aryl ether ketone) (P1) are recurring units (R1). Still more preferably, essentially all the recurring units of the poly(aryl ether ketone) (P1) are recurring units (R1). The most preferably, all the recurring units of the poly(aryl ether ketone) (P1) are recurring units (R1).

[0069] Excellent results were obtained when the poly(aryl ether ketone) (P1) was a PEEK homopolymer, i.e. a polymer of which essentially all, if not all, the recurring units are of formula (VII).

[0070] The poly(aryl ether ketone) (P1) has a reduced viscosity (RV) of advantageously at least 0.55 dl/g and preferably of at least 0.70 dl/g; besides, the RV of the poly(aryl ether ketone) (P1) is advantageously of at most 1.10 dl/g and preferably of at most 0.90 dl/g. The reduced viscosity (RV) is measured in 95-98% sulfuric acid ($d=1.84$ g/ml) at a poly(aryl ether ketone) concentration of 1 g/100 ml. The measurement is performed using a No 50 Cannon-Fleske viscometer. RV is measured at 25° C. in a time less than 4 hours after dissolution, to limit sulfonation.

[0071] The poly(aryl ether ketone) (P1) can be prepared by any method.

[0072] One well known in the art method contains reacting a substantially equimolar mixture of at least one bisphenol and at least one dihalobenzoid compound or at least one halophenol compound as described in Canadian Pat. No. 847,963. Preferred bisphenols in such a process are hydroquinone, 4,4'-dihydroxybiphenyl and 4,4'-dihydroxybenzophenone; preferred dihalobenzoid compounds in such a process are 4,4'-difluorobenzophenone, 4,4'-dichlorobenzophenone and 4-chloro-4'-fluorobenzophenone; preferred halophenols compounds in such a process are 4-(4-chlorobenzoyl)phenol and (4-fluorobenzoyl)phenol. Accordingly, PEEK homopolymers may notably be produced by the

nucleophilic process as described in, for example, U.S. Pat. No. 4,176,222, the whole content of which is herein incorporated by reference.

[0073] Another well known in the art method to produce PEEK homopolymers comprises electrophilically polymerizing phenoxyphenoxybenzoic acid, using an alkane sulfonic acid as solvent and in the presence of a condensing agent, as the process described in U.S. Pat. No. 6,566,484, the whole content of which is herein incorporated by reference. Other poly(aryl ether ketone)s may be produced by the same method, starting from other monomers than phenoxyphenoxybenzoic acid, such as those described in U.S. Pat. Appl. 2003/0130476, the whole content of which is also herein incorporated by reference.

Optional Ingredients of the Polymer Compositions (C1) and (C2)

[0074] The polymer compositions (C1) and (C2) may further contain conventional ingredients of poly(aryl ether ketone) compositions, including lubricating agents, heat stabilizers, anti-static agents, organic and/or inorganic pigments like TiO₂, carbon black, acid scavengers, such as MgO, stabilizers, i.e. metal oxides and sulphides such as zinc oxide and zinc sulphide, antioxidants, flame retardants, smoke-suppressing agents, and fillers, collectively referred to as ingredients (A).

[0075] If ingredients (A) are present, their weight, based on the total weight of the polymer composition (C1) [or based on the total weight of the polymer composition (C2)], is advantageously below 50%, preferably below 30%, more preferably below 10% and still more preferably below 5%. Excellent results were observed when the polymer compositions (C1) and (C2) were free of ingredients (A), i.e. they consisted of the poly(aryl ether ketone) (P1) and the poly(biphenyl ether sulfone) (P2).

[0076] The polymer compositions (C1) and (C2) can be prepared by any conventional mixing method. A preferred method contains dry mixing the ingredients of the polymer compositions of concern in powder or granular form, using e.g. a mechanical blender, then extruding the mixture into strands and chopping the strands into pellets.

[0077] Non limitative examples of parts of shaped articles or shaped articles or assemblies of shaped articles susceptible of being in accordance with the present invention include bearings, anti-friction bearing cages, metal polymer bearings, thrust washers, brush washers, bushings, seal rings, slides, cable carriers, ball bearing balls, cam followers and gears. Other ones are electronic components or devices, including semiconductor chips, connectors such as electrical plug-in connectors and mono-block electrical connectors, capacitors, light emitting diodes (LEDs), relays, sensors, coils, switches, electronic substrates such as printed circuit boards (PCB), retention members for electrical contacts, integrated circuit test sockets, high temperature resistant bobbins for relays and solenoids, trimming potentiometer rotors, sensor housing and covers, and substrates for hole or surface mounting.

[0078] Provided below are examples illustrative of the present invention, but not limitative thereof.

EXAMPLES

[0079] Five polymer compositions were prepared by blending PEEK with PPSU in various amounts, namely polymer compositions E1, E2, E3, E4 and E5. Polymer compositions

composed of PEEK only on one hand, and PPSU only on the other hand, were also prepared as comparative examples, namely polymer compositions CE1 and CE2. The nature and amount of all the ingredients contained in the exemplified polymer compositions are listed in table 1.

TABLE 1

Ingredients	Samples formulation						
	CE1	E1	E2	E3	E4	E5	CE2
VICTREX ® 150P PEEK	100	90	80	70	60	50	0
RADEL R ® 5000 NT PPSU	0	10	20	30	40	50	100

VICTREX ® 150P powdered PEEK resin was available from VICTREX Manufacturing Ltd. and RADEL ® R 5000 NT PPSU resin was available from SOLVAY ADVANCED POLYMERS, L.L.C.

Preparation of Specimens of the Polymer Compositions.

[0080] All polymer compositions were prepared by melt compounding the ingredients as listed in Table 1, using a Berstorff 25 mm twin screw extruder having eight barrel segments with seven heated zones and an overall length to diameter ratio of 33:1. The extruder was equipped with a vacuum vent at barrel 6 which was maintained under vacuum during all the compounding runs. The compositions were fed to the extruder by metering the ingredients into the feed throat of the extruder using gravimetric feeders which feed them at the appropriate rates to produce the desired blend ratio in each case. Detailed compounding conditions are shown in Table 2. The compounded resins were stranded into a water trough for cooling and solidification and was then diced into pellets.

TABLE 2

	Compounding Run Parameters Used for Compounding	
	Set Points	
	For CE1, E1, E2, E3, E4 and E5	For CE2
Barrel 2 Temp. (° C.)	330	315
Barrel 3 Temp. (° C.)	330	320
Barrel 4 Temp. (° C.)	340	350
Barrel 5 Temp. (° C.)	350	345
Barrel 6 Temp. (° C.)	350	345
Barrel 7 Temp. (° C.)	350	340
Barrel 8 Temp. (° C.)	350	345
Die Adapter (° C.)	360	345
Die (° C.)	360	345
Melt Temperature (° C.)	390-400	390-395
Screw Speed (rpm)	230	220

Abrasion Resistance Test

[0081] Taber® abrasion tests were run, using a Taber® abramer equipped with CS-17 "Calibrase" wheels (having a durometer hardness of 72±5, measured using ASTM D-676) and a 1000 g loading weight. All samples were aged for 4 days before testing at Standard Laboratory Atmosphere conditions (23° C. and 50% R.H.). Each sample (4 sq. inch (25.81 cm²) plate having a ¼ inch diameter (0.63 cm) hole in center) was weighted to the closest 0.1 mg. Samples were then submitted to 2000 cycles (by 4-500 cycles unit). Samples were weighted after each 500 cycles, as well as unabraded control specimens. Weight gain or losses of control specimens were

deemed to represent changes in moisture content. Weight losses of the abraded samples were thus corrected by the amount of moisture lost or gained by the unabraded control specimen to arrive at the correct weight of abraded material for each 500 cycles.

Results.

[0082] The abrasion test results are provided in table 3.

TABLE 3

Taber abrasion test results	
Sample	Weight after abrasion test/ initial weight (g/g)
CE1	0.957
E1	0.964
E2	0.961
E3	0.959
E4	0.960
E5	0.951
CE2	0.944

[0083] FIG. 1 provides a graphical representation of these results. The weight after abrasion test/initial weight was plotted versus the PPSU wt. % of the different polymer compositions that were tested.

[0084] These experimental data showed surprisingly that diluting PEEK by an effective amount of PPSU results in PEEK-PPSU blends having at least substantially the same abrasion resistance as neat PEEK, while neat PPSU exhibited poor abrasion resistance in the same test. More surprisingly, the Applicant has even found that blends presenting as high as 40 wt. % of PPSU, showed increased resistance towards abrasion than neat PEEK itself.

1-16. (canceled)

17. A method for diluting a poly(aryl ether ketone) (P1) contained in a polymer composition (C1) while at least substantially maintaining the friction and/or wear resistance of the polymer composition (C1) in the need thereof

said polymer composition (C1) consisting of the poly aryl ether ketone) (P1) and, optionally in addition, one or more ingredients (A) other than the poly(aryl ether ketone) (P1) and a poly(biphenyl ether sulfone) (P2),

said friction and/or wear resistance of the polymer composition being at least substantially maintained with regard to a surface (Σ) with regard to which respectively the friction and/or wear resistance of the poly(biphenyl ether sulfone) (P2) are not as good as respectively the friction and/or wear resistance of the poly(aryl ether ketone) (P1),

said method comprising diluting the poly(aryl ether ketone) (P1) an effective amount (ϵ) of the poly(biphenyl ether sulfone) (P2).

18. The method according to claim 17, wherein the effective amount (ϵ) of the poly(biphenyl ether sulfone) P2) is below 40 parts by weight (pbw.),

said effective amount (81 of the poly(biphenyl ether sulfone) (P2) diluting the polyaryl ether ketone) (P1) contained in the polymer composition (C1) in an amount of 100 pbw., by replacing in said polymer composition (C1), ϵ pbw. of the poly aryl ether ketone) (P1) by ϵ pbw. of the poly(biphenyl ether sulfone) (P2), thereby obtaining a polymer composition (C2) consisting of (100- ϵ) pbw. of the poly(aryl ether ketone) (P1), ϵ pbw. of the

poly(biphenyl ether sulfone) (P2), and, optionally in addition, the one or more ingredients (A).

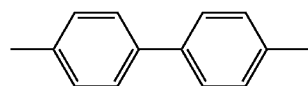
19. The method according to claim 18, wherein the effective amount (ϵ) of the poly(biphenyl ether sulfone) (P2) is below 30 pbw.

20. The method according to claim 18S wherein the effective amount (ϵ) of the poly(biphenyl ether sulfone) (P2) ranges between 2 and 25 pbw.

21. The method according to claim 17 wherein the friction and/or wear resistance of the polymer composition (C1) are at least essentially maintained.

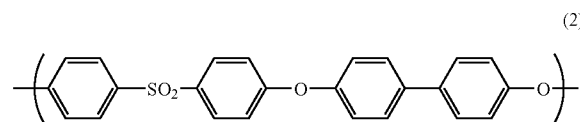
22. The method according to claim 17, wherein the wear resistance of the polymer composition (C1) with regard to the surface (Σ) is at least substantially maintained.

23. The method according to claim 17, wherein the poly(biphenyl ether sulfone) (P2) is a polymer of which essentially all the recurring units are recurring units (R2) of one or more formulae containing at least one p-biphenylene group:

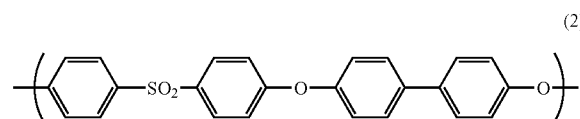


at least one ether group ($-\text{O}-$) and at least one sulfone group ($-\text{SO}_2-$).

24. The method according to claim 17 wherein the poly(biphenyl ether sulfone) (P2) is a polymer of which more than 50 wt. % of the recurring units are recurring units (R2) of formula

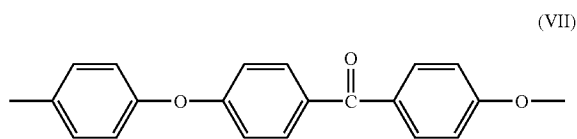


25. The method according to claim 17, wherein the poly(biphenyl ether sulfone) (P2) is a polyphenylsulfone (PPSU) homopolymer of which essentially all the recurring units are recurring units (R2) of formula

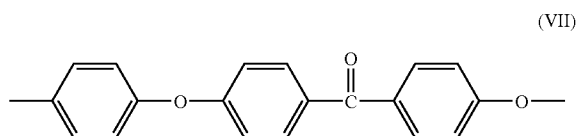


26. The method according to claim 17, wherein the poly(aryl ether ketone) (P1) is a polymer of which essentially all the recurring units are recurring units (R1) of one or more formulae containing at least one arylene group, at least one ether group ($-\text{O}-$) and at least one ketone group [$-\text{C}(=\text{O})-$].

27. The method according to claim 17, wherein the poly(aryl ether ketone) (P1) is a polymer of which more than 50 wt. % of the recurring units are recurring units (R1) of formula



28. The method according to claim 17, wherein the poly(aryl ether ketone) (P1) is a PEEK homopolymer of which essentially all the recurring units are recurring units R1) of formula



29. The method according to claim 17, wherein part or all of the surface (Σ) is constituted of a material selected from the group consisting of metals, steel, bronze and high engineering thermoplastics.

30. The method according to claim 18, which is a method for diluting the poly(aryl ether ketone) (P1) while at least substantially maintaining the wear resistance of the polymer composition (C1), wherein the wear resistance of the polymer compositions (C1) and (C2) with regard to the surface (Σ) is assessed by means of a Taber® abramer comprising an abrader wheel evaluating the haze variation or weight loss of the polymer compositions (C1) and (C2) after they have been placed on top of the abrader wheel and have been allowed to spin for a specified number of revolutions.

31. The method according to claim 17, wherein the polymer composition (C1) is in the form of a shaped article or a part of shaped article (S1).

32. A polymer composition (C2) consisting of:
a poly(aryl ether ketone) (P1)
an effective amount (ϵ) of a poly(biphenyl ether sulfone) (P2), and
optionally in addition, one or more ingredients (A) other than the poly(aryl ether ketone) (P1) and the poly(biphenyl ether sulfone) (P2),

wherein the friction and/or wear resistance of said polymer composition (C2) with regard to a surface (Σ) with regard to which respectively the friction and/or wear resistance of the poly(biphenyl ether sulfone) (P2) are not as good as respectively the friction and/or wear resistance of the poly(aryl ether ketone) (P1), are at least substantially maintained, when compared to those of a polymer composition (C1) identical to the polymer composition (C2), except the poly biphenyl ether sulfone) (P2) contained in the polymer composition (C2) has been completely replaced, weight pro weight, by the poly(aryl ether ketone) (P1).

33. A shaped article (S2) composed of the polymer composition (C2) according to claim 32.

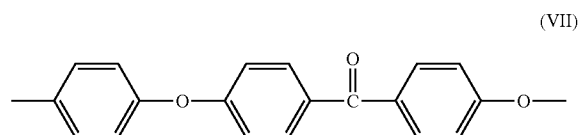
34. A part of a shaped article (S2) composed of the polymer composition (C2) according to claim 32.

35. An article assembly comprising the part according to claim 34.

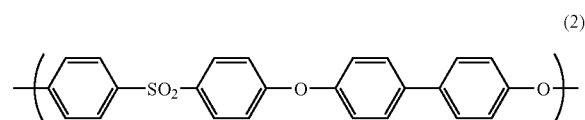
36. A method for diluting a poly(aryl ether ketone) (P1) contained in a polymer composition (C1) in an amount of 100 parts by weight (pbw), while at least substantially maintaining the wear resistance of the polymer composition (C1) in the need thereof,

said polymer composition (C1) consisting of the poly(aryl ether ketone) (P1) and, optionally in addition, one or more ingredients (A) other than the poly(aryl ether ketone) (P1) and a poly(biphenyl ether sulfone) (P2),

said poly(aryl ether ketone) (P1) being a PEEK homopolymer of which essentially all the recurring units are recurring units (R1) of formula



said poly(biphenyl ether sulfone) (P2) being a polyphenylsulfone (PPSU) homopolymer of which essentially all the recurring units are recurring units (R2) of formula



said wear resistance of the polymer composition (C1) being at least substantially maintained with regard to a surface (Σ) with regard to which respectively the wear resistance of the poly(biphenyl ether sulfone) (P2) are not as good as respectively the wear resistance of the poly(aryl ether ketone) (P1),

said method comprising diluting the poly(aryl ether ketone) (P1) by an effective amount (ϵ) of below 50 pbw. of the poly(biphenyl ether sulfone) (P2), by replacing in said polymer composition (C1), ϵ pbw. of the poly(aryl ether ketone) (P1) by ϵ pbw. of the poly(biphenyl ether sulfone) (P2), thereby obtaining a polymer composition (C2) consisting of (100- ϵ) pbw. of the poly(aryl ether ketone) (P1), ϵ pbw. of the poly(biphenyl ether sulfone) (P2), and, optionally in addition, the one or more ingredients (A),

wherein the wear resistance of the polymer compositions (C1) and (C2) with regard to the surface (Σ) is assessed by means of a Taber® abramer comprising an abrader wheel, evaluating the haze variation or weight loss of the polymer compositions (C1) and (C2) after they have been placed on top of the abrader wheel and have been allowed to spin for a specified number of revolutions.

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